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Water loss and the origin of thick ultramylonites

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Hydrolytic weakening has been suggested as a major process facilitating strain localisation, consistent with many studies that have found a positive correlation between water content and intensity of deformation. We examine the role of water in an unusually thick shear zone: the 1 km-thick ultramylonitic layer of the El Pichao shear zone, NW Argentina. We used Fourier Transform Infrared Spectroscopy to measure water content in quartz and feldspar, comparing ultramylonitic rocks to mylonites and weakly-deformed rocks. We found that quartz and feldspar in ultramylonites contained half the amount of water of weakly-deformed rocks, contrary to findings in previous studies. We propose that the kilometre-thick ultramylonite formed in three stages: (1) localised deformation and recrystallisation caused release of intracrystalline water to grain boundaries, which promoted grain-boundary sliding, forming the ultramylonite, (2) high pressure in the shear zone continuously expelled intercrystalline water to the surroundings, drying the boundaries and leading to strain hardening, (3) water migrated to neighbouring, less-deformed rocks causing hydrolytic weakening, repeating the cycle, and widening the ultramylonite.